Fire Regime Condition Class (FRCC) Interagency Handbook
Reference Conditions

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PNVG Code: WPHE

Potential Natural Vegetation Group: Great Lakes pine forests: White pine–Hemlock (i.e., fine textured glacial lakebeds and dry-mesic ice contact topography).

Geographic Area: Northern lower Michigan and northern Wisconsin.

Description: Hemlock and white pine have wide ecological amplitudes, occurring with wetland conifers in poorly-drained landforms and with mesophilic northern hardwoods in morainal upland landforms. White pine and hemlock become dominant within mixed forests, however, in upland ice-contact and glacial lakebeds landforms of intermediate soil fertility. These landscape ecosystems typically have low proportions of sugar maple and associated mesophilic deciduous species due to limited soil nutrient availability or moisture holding capacity. Species adapted to frequent disturbance (e.g., jack pine, aspen) occur in low proportions.

In the mid-1800s, there were 2.2 million acres of white pine - hemlock ecosystems within the 10.6 million acres of forestlands in northern lower Michigan (Province 212; Cleland et al. 2004, ongoing R-9/SRS/MTU study). Based on analysis of GLO line tree observations, these white pine – hemlock communities were dominated by “pine” recorded to the genus level, followed by hemlock, white pine, red pine, and beech (Figure 1). It is likely much of the undifferentiated pine was white pine given the large diameters of this class (mean of 19.3 inches), which on average were the largest recorded across all species. Pine and hemlock comprised 62% of GLO line trees, mesophilic sugar maple 3%, and early successional oak, white birch, and aspen 10%.

In the mid-1800s, there were 3.2 million acres of white pine – hemlock – birch ecosystems within the 17.8 million acres of forestlands in northern Wisconsin (Cleland et al. 2004a, ongoing R-9/SRS/MTU study). These landscape ecosystems were dominated by three communities identified by Schulte et al. (2002) as hemlock, hemlock - white pine, and hemlock – yellow birch (Figure 2). Pine and hemlock comprised 33% of GLO line trees, mesophilic sugar maple and yellow birch about 17%, and early successional oak, white birch, and aspen about 20%. The white pine – hemlock forests of Wisconsin were more diverse than those of northern lower Michigan, with higher proportions of both early and late successional deciduous species. This may be due to the prevalence of wetlands and lakes within Wisconsin, providing sheltered landscape positions favoring sugar maple, and poorly drained soils favoring yellow and white birch, and quaking aspen..

Much of the white pine –hemlock PNVG was in an old growth state, and relatively low densities of tall, large diameter trees dominated the landscape. Old-growth white pine – hemlock stands were often partially multi-aged (Holla and Knowles 1988) or uneven-aged due to continuous recruitment caused by local disturbances (Quinby 1991). Rogers (1978) reported only 8% of the hemlock stands sampled from Wisconsin to Nova Scotia were even-aged, indicating that very few of the hemlock stands were initiated after a catastrophic event such as a wildfire. In a study of old growth white pine in Canada (Guyette and Dey 1995), canopy dominance and tree size suggested an even-aged structure, whereas actual ages of dominant trees ranged from 267 to 486 years. White pine older than 400 years made up 20% of the dominant trees, 52% were 300 to 400 years old, and 28% were 250 to 300 years old. White pine persisted as the dominant species over a seven century period in an old-growth white pine forest of Canada, indicating that white pine was self-replacing (Quinby 1991).

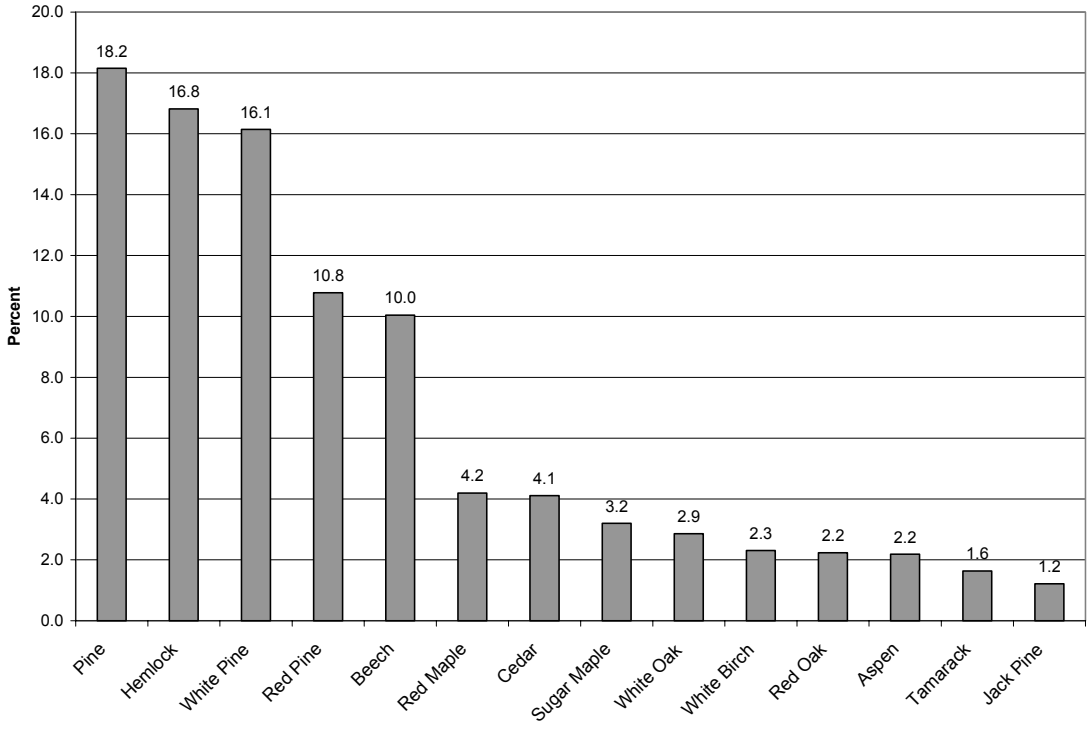

Figure 1. Percentage of trees in each species recorded within GLO corner notes for the "white pine - hemlock" potential natural vegetation group of northern lower Michigan.

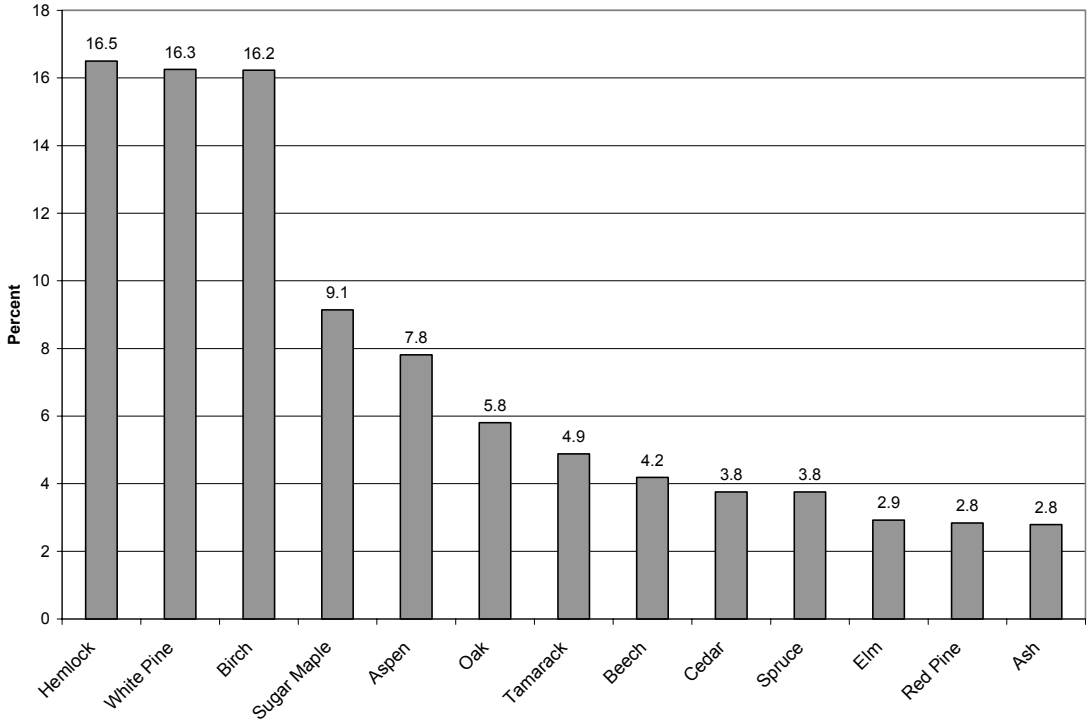

Figure 2. Percentage of trees in each species recorded within GLO corner notes for the "white pine – hemlock - birch" potential natural vegetation group of northern Wisconsin.

Fire Regime Description: Fire regime group III with fires occurring every 100+ years and mixed severity. Severe wind events affect mature stands on an approximate 500 year interval.

The hemlock – white pine forests of northern lower Michigan and Wisconsin were disturbed by large-scale stand replacing crown fires within rotations of 400 – 500 years (Cleland et al. 2004a) and by wind events of comparable rotations. During the centuries between catastrophic disturbances, low-intensity small surface fires, windthrown trees and the death of large individual trees through biological or other agents interacted to regulate stand-scale gap dynamics.

The complex structure and age-class distribution of this ecosystem are due to these two distinct disturbance regimes. Broad-scale crown fires occurred very infrequently, selecting for pyrophilic species capable of reproducing in full-light conditions following stand-replacing disturbance. Fine-scale single or group tree mortality and blowdown occurred continuously, and selected for shade-tolerant and mid-shade-tolerant species.

Once white pine has matured and attained larger diameters and crown height, widely spaced dominants are highly resistant to intense surface or maintenance fires (Beverly and Martell 2003). Hemlock is injured or killed by intense surface fires, and both hemlock and white pine suffer high rates of mortality following crown-fires. The successional dynamics of this ecosystem after mixed or severe crown fires may involve establishment of aspen-birch or white pine immediately following the disturbance, with subsequent succession to white and red pine and oak, followed by late successional gap-phase invasion of hemlock and yellow birch beneath white pine during long fire-free periods (Davis et al. 1992).

Successional trajectories were historically regulated by disturbance regime, as well as landscape-level patterns in communities and environment, and localized edaphic conditions. Landscape-level patterns of lakes, wetlands, deciduous species, openlands, and other fuel discontinuities determined fire-exposed versus fire-protected landscape positions (Dovciak et al. 2003). Within landforms, localized conditions of soil texture and drainage, and resulting gradients of available nutrients and moisture impeded invasion by nutrient-demanding shade-tolerant hardwoods (Rogers 1978).

Preferential recruitment of hemlock beneath white pine, and development of mor-like soil organic horizons within hemlock stands that inhibited hardwood invasion (Davis et al. 1994), are examples of biologically mediated successional dynamics. All these natural processes and factors have had a strong selective effect on the age, structure, and composition of these forests.

Vegetation Type and Structure

Class*	Percent of Landscape	Description
A: post replacement Early seral	5	Stands primarily comprised of early seral aspen, birch, and other hardwood species
B: mid-seral	15	Mixed white oak, red oak, and red maple stands. White pine will develop in the understory of these stands and eventually overtop them.
C late seral closed young	25	Red pine and young white pine stands generally < 100 years of age. Succeed to older white pine stands
D: late seral closed old	55	Mature white pine stands. Over time, and in fire's absence, an associate of large hemlock may develop
Total	100	

Infrequent fires occur on about a 200-year return interval. Approximately half of these fires are replacement, making this a mixed severity regime. Fire regime/severity assumptions by class follow:

A: **Early seral**: Surface fires in aspen/birch stands are replacement and set this class back to age 0. These stands vigorously resprout to aspen.

B: **Mid seral: Oak/red maple**. Fires in this class are 50 % replacement and 50 % mixed. Replacement fires result in an early seral aspen/birch stand (Class A: 50%) or the oak may resprout and result in a young oak stand (Class B: 50%). Stands that escape replacement fire develop a white pine understory. These stands succeed to mature white pine after 200 years.

C: **Red pine and young white pine stands generally < 100 years:** These stands may or may not contain red pine. In the absence of fire, red pine stands develop a white pine understory and succeed to mature white pine stands. An even mix of replacement and mixed fires is assumed. Replacement fires either revert the stand to early seral (Class A) or back to a young pine stand. The result of a replacement fire is largely dependent upon the age of the stand burned and the ability of red and white pine to reseed the burned area. Mixed severity mixed fires may also occur, setting the stand back 25 years.

D **Mature white pine – hemlock stands:** Mature and old growth stands

Fire Severity	Fire Frequency (yrs)	Probability	Percent, All Fires	Description
Replacement Fire	400	.0025	50	All fires in barrens and 80 % of fires in mature jack pine are replacement
Non-Replacement Fire	400	.0025	50	Primarily surface fire in older red pine. Mixed fire in young classes.
All Fire Frequency*	200	.005	100	

*All Fire Probability = sum of replacement fire and non-replacement fire probabilities. All Fire Frequency = inverse of all fire probability (previous calculation).

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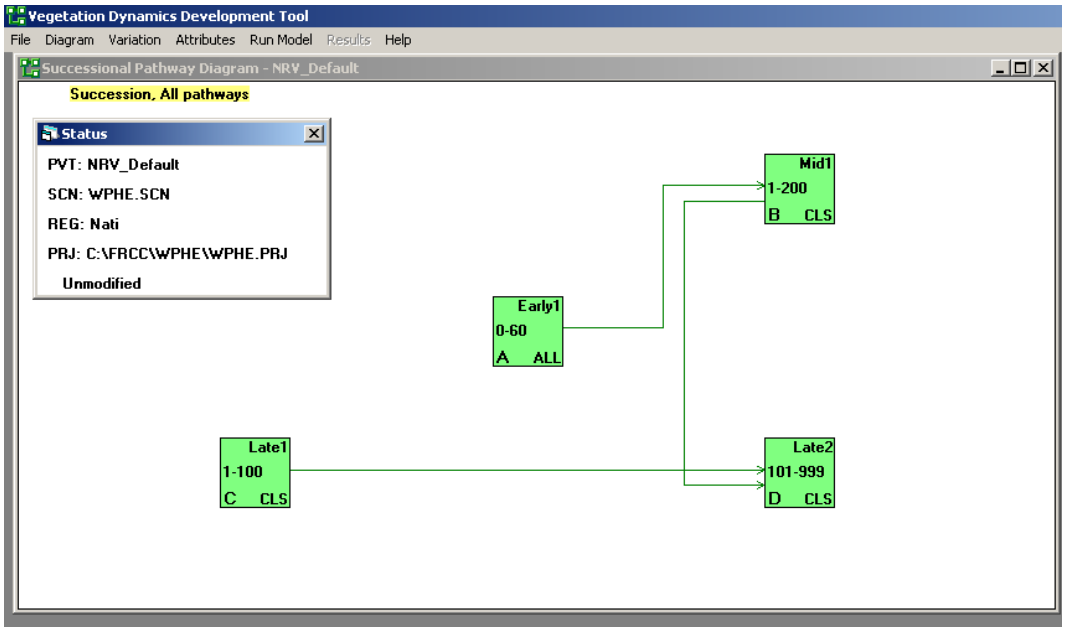
VDDT file documentation: Model WPHE located in C:/FCCC/WPHE: Load VDDT text files into C:/FRCC for project file to work. The diagram shows succession only.



Disturbances by class: **Model WPHE**

Class	To	Agent	Prob	TSD	Freq/ FRI	Rel Age
A	A	Replacement fire	.005	10	200	-60
A	A	Wind/weather/stress	.001	0	1000	-60
A	C	AltSuccession**	.2	0	NA	0
B	A	Replacement fire	.00125	0	800	0
B	B	Replacement fire	.00125	0	800	-200
B	B	Surface fire	.0025	0	400	0
B	B	Wind/weather/stress	.0015	0	667	-200
C	A	Replacement fire	.00125	0	800	0
C	C	Replacement fire	.00125	0	800	-100
C	C	Mixed fire	.0025	0	400	-25
C	C	Wind/weather/stress	.001	0	1000	-100
D	A	Replacement fire	.0005	0	2000	0
D	C	Replacement fire	.0020	0	500	0
D	D	Surface fire	.0025	0	400	0
D	C	Wind/weather/stress	.002	0	500	0

*** Alternative succession is only applied at the last age of the class. On the VDDT disturbance (Pathways from) table select **Display,** then **Show Ages**, to apply.*

Class A – Early seral Aspen/Birch: All fires are replacement and occur after 10 years have elapsed since the previous fire (TSD=10). Class A succeeds to a oak/red maple

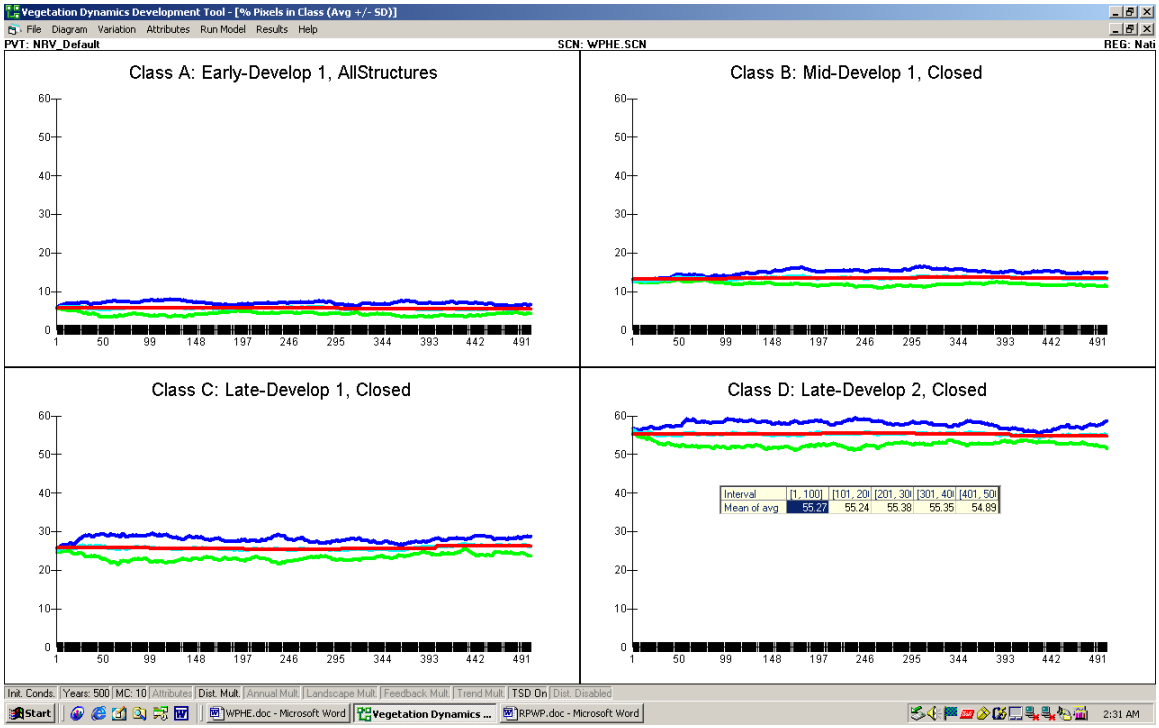
stand (class B). AltSuccession disturbance is used to succeed 20% of this class to young red pine/white pine (class C).

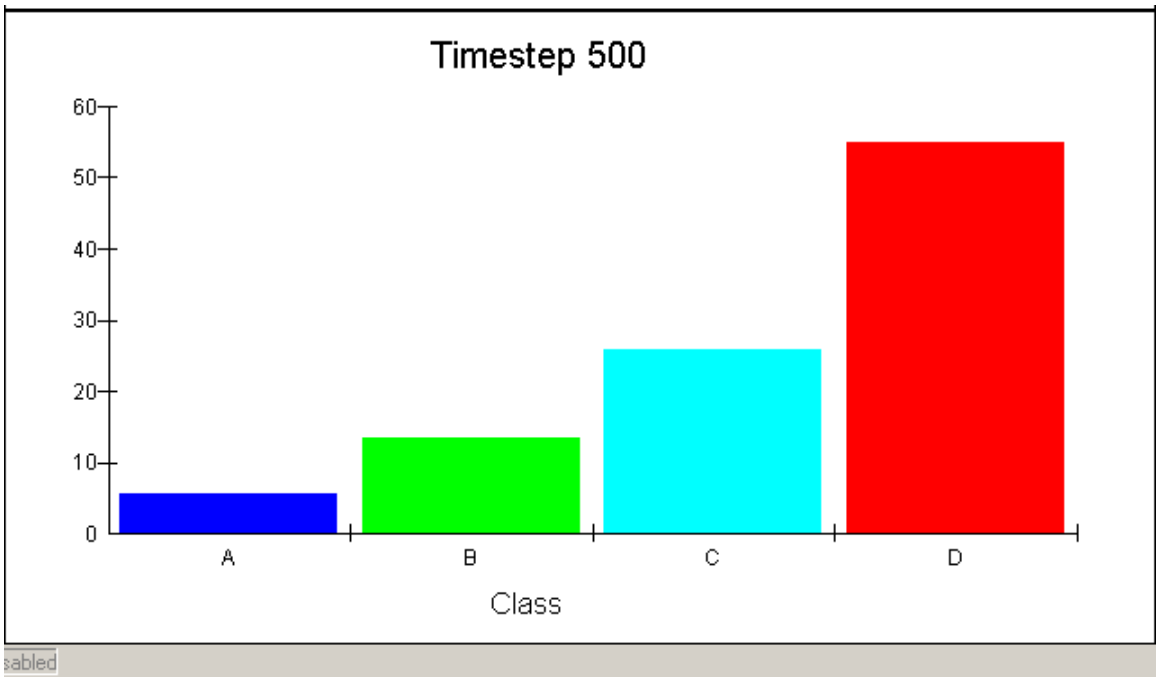
Class B -Mid seral Oak/red maple: These stands may persist for 200 years without fire disturbance. They eventually develop a white pine understory that overtops the hardwoods and succeed to class D.

Class C - Red pine and young white pine stands generally < 100 years: Replacement fires in stands < 50 years old revert to aspen/birch due to lack of pine seeding. Older stands, when burned, are assumed to regenerate to pine.

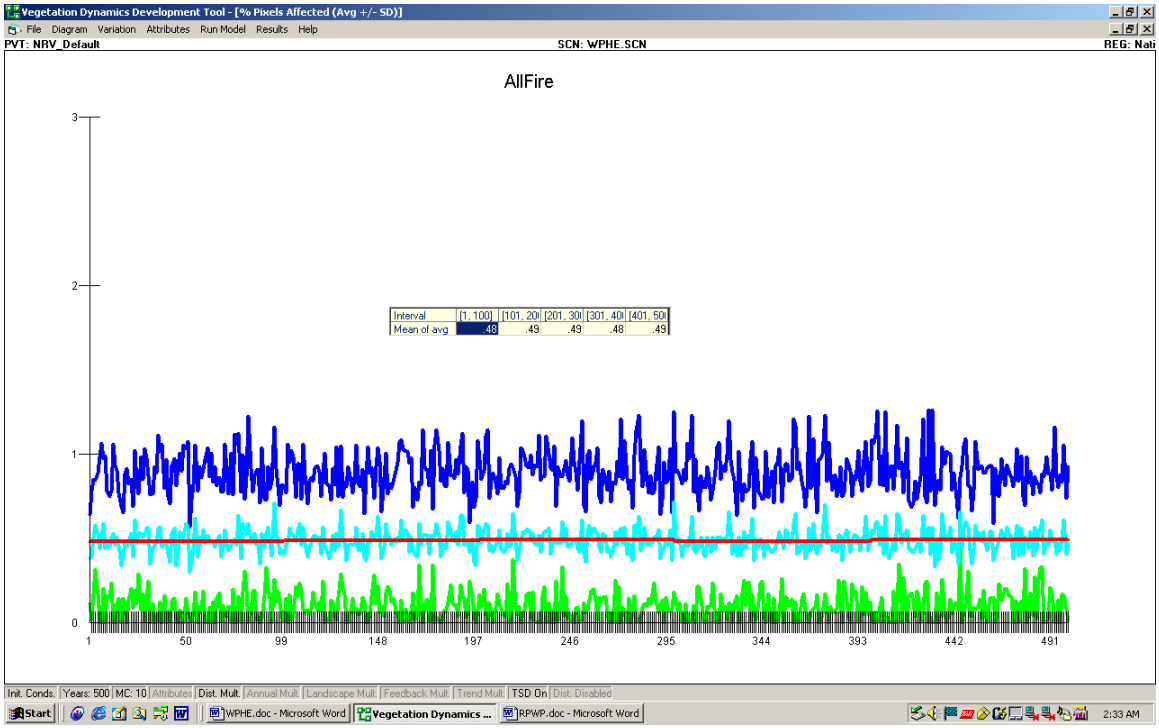
Class D – Mature white pine stands > 100 years: A small proportion of stands (20%) revert to aspen/birch following replacement fire. The remainder regenerate to pine.

Results graphs: These graphs show the average per cent of area in each class projected for 500 years. These are 10-year-average graphs + or - 2 SD's.

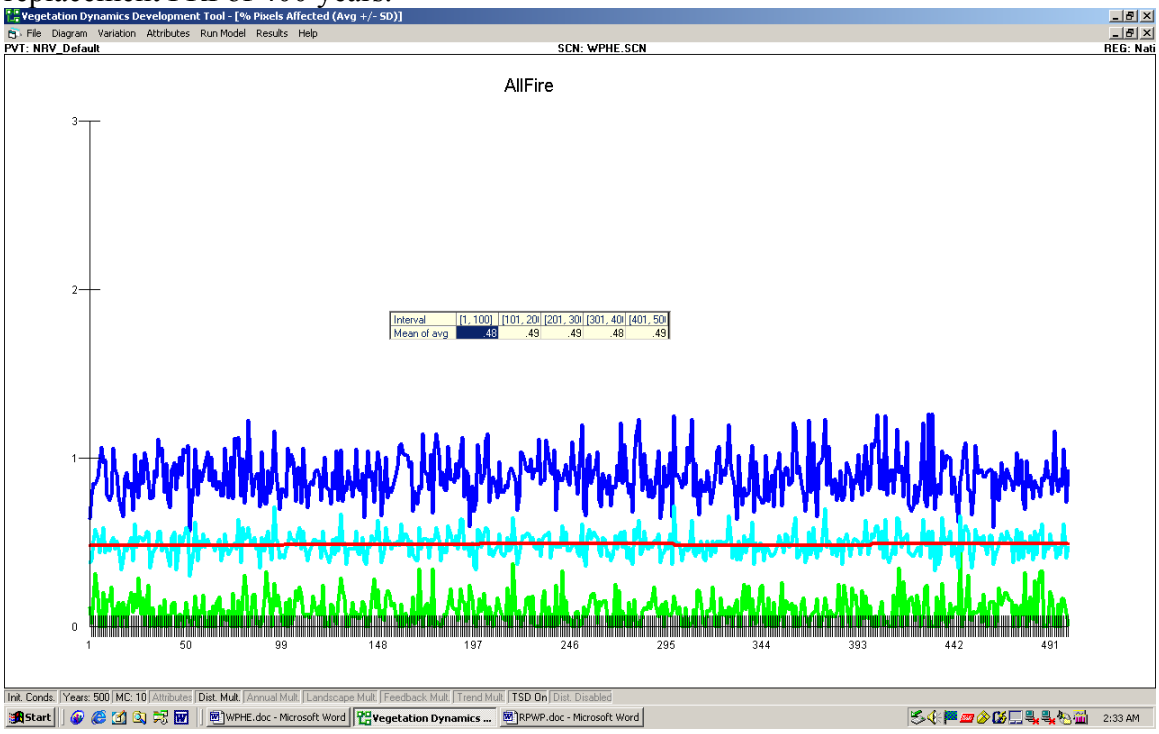




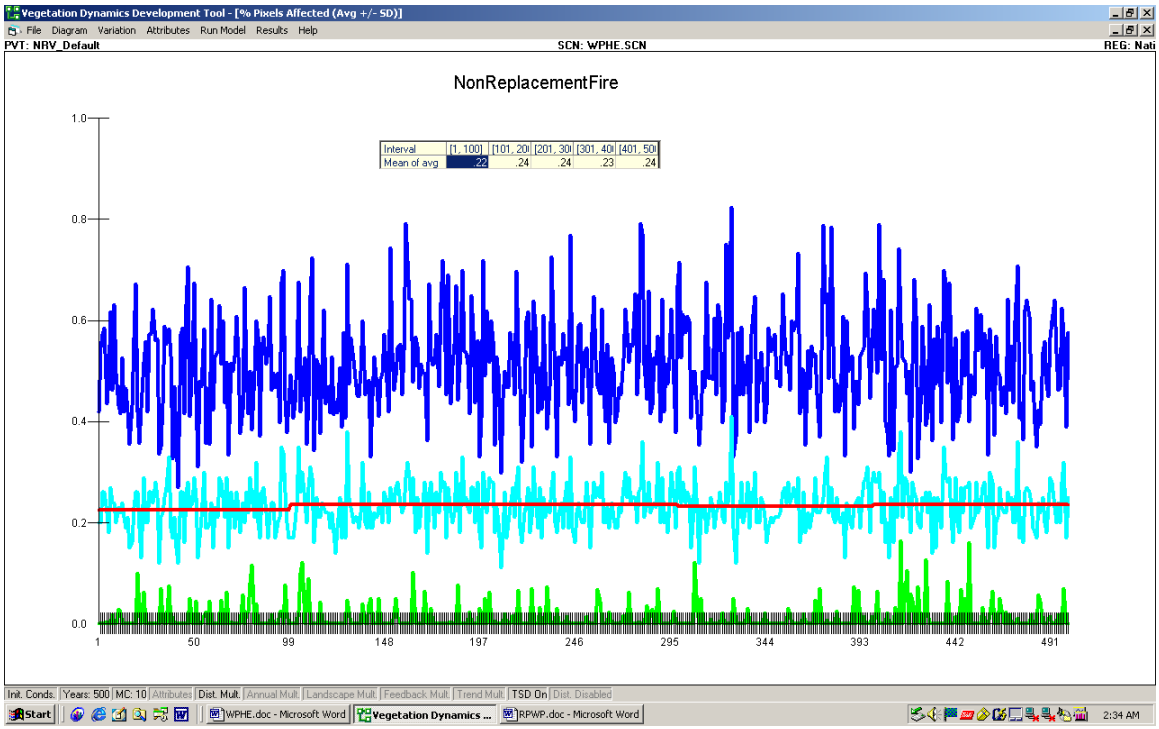
All fire frequency: Approximately 0.5% burns per year for a FRI of about 200 years.



Replacement fire frequency: Approximately 0.25% of the area burns per year for a replacement FRI of 400 years.



Non-replacement fire frequency: Approximately 0.24% of the area burns per year for a non-replacement FRI of about 400 years



CatastrophicWindthrow frequency: Approximately 0.16% of the area is affected by catastrophic windthrow per year for a windthrow interval of about 625 years.